



University of Technology, Sydney

**TO BE RETURNED AT THE END OF THE EXAMINATION.
THIS PAPER MUST NOT BE REMOVED FROM THE EXAM CENTRE.**

SURNAME: _____

FIRST NAME: _____

STUDENT NUMBER: _____

COURSE: _____

**FINAL EXAMINATION
AUTUMN SEMESTER 2011**

SUBJECT NAME : CONCRETE TECHNOLOGY AND PRACTICE

SUBJECT NO. : 49151

DAY/DATE : Friday, 17th June 2011

TIME ALLOWED : 3 Hours plus 10 Min. reading time

START/END TIME : 6:00 pm to 9:10 pm

NOTES/INSTRUCTIONS TO CANDIDATES:

Number of questions: 4

Read all questions carefully

All questions are to be answered

All questions are of equal value

All answers are to be legibly written in ink in answer booklets provided

Pencil may be used for all drawings, sketches and graphs

Ensure to label all axes on all graphs

Only pocket (non-programmable) calculators are to be used

Question One (25 marks)

Part 1A: Multiple Choice Questions (5 marks)

For each question below, select one correct answer and write down the letter in your answer booklet.

- i) A concrete mix is found to contain 15% Portland cement by volume, 20% water by volume and 6% air content by volume. This mix is typically representative of:
- a) Lean and non-air-entrained concrete
 - b) Rich and non-air-entrained concrete
 - c) Rich and air-entrained concrete
- ii) What type of Portland cement would you use for construction in cold weather?
- a) Type HE
 - b) Type GB
 - c) Type SL
- iii) The use of ground granulated blast furnace slag for partial replacement of Portland cement in concrete can improve the properties of concrete in what set of ways:
- a) Heat evolved decreases and permeability decreases
 - b) Heat evolved increases and permeability decreases
 - c) Heat evolved increases and permeability increases
- iv) Use of what type of aggregate grading would maximise the extent of segregation occurring in a concrete mix:
- a) Continuous grading
 - b) Gap grading
 - c) Single size grading
- v) In addition to using WR admixture in a concrete mix, which other admixture may also be used to improve the workability of concrete?
- a) Ac
 - b) Re
 - c) AEA

Part 1B: List and Describe Short Answer Questions (10 marks)

Provide short answers for the following questions in your answer booklet.

- i) List and briefly describe two characteristic features of the tricalcium aluminate (C_3A) compound in Portland cement after hydration.
- ii) List and briefly describe three harmful effects on the properties of concrete when mixing water containing excessive impurities is used to produce concrete.

Part 1C: Calculation Questions (10 marks)

Provide the answers and show complete workings for the following questions in your answer booklet.

i) The moisture content (MC) of aggregate is calculated from weight of aggregate 'as batched' (w_{agg}) and weight of aggregate after oven-drying (w_{od}). Similarly, the absorption capacity (AC) is calculated from weight of aggregate in saturated surface dry condition (w_{ssd}) and weight of aggregate after oven-drying (w_{od}). Use these two relationships to show how the following equation is obtained.

- $w_{ssd} = [w_{agg} / (1 + MC)] \times (1 + AC)$

ii) Determine the free water-to-cement (w/c) ratio in a proportioned batch of concrete containing the following raw materials:

- Portland cement = 16 kg
- Fine aggregate = 20 kg
- Coarse aggregate = 50 kg
- Mixing water = 8 kg

Tests carried out on the raw materials gave the following results:

- Moisture content of fine aggregate = 5.0%
- Moisture content of coarse aggregate = 1.0%
- Absorption capacity of fine aggregate = 2.0%
- Absorption capacity of coarse aggregate = 0.5%

Question Two (25 marks)Part 2A: Multiple Choice Questions (5 marks)

For each question below, select one correct answer and write down the letter in your answer booklet.

- i) The rheology of fresh concrete is influenced the most by which factor:
- a) Mix temperature
 - b) Mixing duration
 - c) Aggregate type
- ii) A concrete mix is found to have a slump of 60 mm, compacting factor of 0.93 and Vebe time of 2 s. The workable characteristics of this mix would be most suitable for filling what type of formwork:
- a) Heavily reinforced sections
 - b) Normal reinforced sections
 - c) High and straight reinforced sections

- iii) Which workability relationship is true for rich Portland cement concrete mixes?
- As aggregate content of mix decreases, workability decreases
 - As aggregate content of mix decreases, workability increases
 - As aggregate content of mix increases, workability increases
- iv) An in-situ concrete stanchion requires its compressive strength to be determined by use of the Schmidt rebound hammer test. This type of measured strength is defined as:
- Intrinsic strength
 - Potential strength
 - Actual strength
- v) The static chord modulus of elasticity of concrete will be highest for what set of mix design features:
- Increasing water-to-cement ratio and richer concrete mixes
 - Increasing water-to-cement ratio and leaner concrete mixes
 - Decreasing water-to-cement ratio and leaner concrete mixes

Part 2B: List and Describe Short Answer Questions (10 marks)

Provide short answers for the following questions in your answer booklet.

- List the terms used to describe the four different types of slump patterns observed after a slump test has been carried out on freshly mixed concrete. Briefly describe each type of slump by relating to the workability level and mix design features of the concrete.
- The ultrasonic pulse velocity test is useful for detecting the presence of defects in concrete. List and briefly describe two types of defects detected by this test.

Part 2C: Graphical Relationship Questions (10 marks)

Provide the answers for the following questions in your answer booklet.

- Draw the expected penetration resistance versus elapsed time setting behaviour of fresh concrete entering into its hardened state. On this curve, label the penetration resistance value representing initial set. What term is given to describe the state of concrete at a penetration resistance value of 2.0 MPa?
- Draw the expected stress versus strain relationship of a concrete cylinder tested in uniaxial compression. On this curve, label the region representative of bond and paste cracking and indicate the value of ultimate strength (i. e., relative to ultimate strength) where this region commences.

Question Three (25 marks)

Part 3A: Multiple Choice Questions (5 marks)

For each question below, select one correct answer and write down the letter in your answer booklet.

- i) Which water content mix design relationship is most preferred in achieving the target slump of freshly mixed concrete?
- Increase maximum size of aggregate and increase water content
 - Increase maximum size of aggregate and decrease water content
 - Decrease maximum size of aggregate and decrease water content
- ii) The tolerances set at a concrete plant for weighing different raw materials required to produce various concrete batches would be highest for which type of ingredient used in the mix:
- Manufactured sand
 - Ground granulated blast furnace slag
 - MWR
- iii) What type of external vibrator is most suitable for use in consolidating thin steel reinforced concrete members onsite?
- Form vibrator
 - Vibrating table
 - Surface vibrator
- iv) For the maturity concept of concrete, the 'y = mx + b' relationship is often applied to a graphical plot showing measured M/f versus M data to relate to the following strength-maturity expression:

$$f = (a \times M) / (b + M)$$

What two key parameters are determined from this applied relationship?

- Ultimate strength and time to achieve ultimate strength
 - Ultimate strength and time to achieve 0.5 of ultimate strength
 - 0.5 of ultimate strength and time to achieve 0.5 of ultimate strength
- v) A concrete mix design specification is prescribed as follows:

$$S50/40/60+10/-20$$

The value of 40 listed in this specification represents:

- Strength
- Maximum aggregate size
- Slump

Part 3B: List and Describe Short Answer Questions (10 marks)

Provide short answers for the following question in your answer booklet.

- i) List and briefly describe five ways of curing concrete onsite.

Part 3C: Calculation Questions (10 marks)

Provide the answers and show complete workings for the following question in your answer booklet.

- i) The mean strength and standard deviation of a set of 100 concrete cylinders tested in compression at a concrete batching plant for compliance are reported as 48.2 MPa and 1.7 MPa, respectively. Determine the following strength parameters of this concrete, assuming a 5% defective level (i. e., probability factor of 1.64):
- Characteristic strength
 - Normal-class strength grade rating in accordance with Australian Standard AS 1379-2007 specification and supply of concrete requirements
 - Special-class strength grade rating in accordance with Australian Standard AS 1379-2007 specification and supply of concrete requirements
 - Characteristic flexural strength using the empirical equation available from the Australian Standard AS 3600-2009 concrete structures specification
 - Characteristic tensile strength using the empirical equation available from the Australian Standard AS 3600-2009 concrete structures specification
 - Mean characteristic flexural strength using the empirical equation available from the Australian Standard AS 3600-2009 concrete structures specification
 - Mean characteristic tensile strength using the empirical equation available from the Australian Standard AS 3600-2009 concrete structures specification
 - Sample compressive strength of cylinder 98 given the following information:
 - Sample compressive strength of cylinder 99 = 49.0 MPa
 - Sample compressive strength of cylinder 100 = 47.7 MPa

Question Four (25 marks)Part 4A: Multiple Choice Questions (5 marks)

For each question below, select one correct answer and write down the letter in your answer booklet.

- i) A batch of ready mixed concrete used to fill reinforced formwork for floor slabs exhibits shrinkage cracks 5 h after placement. Such cracks have resulted from:
- Plastic shrinkage
 - Autogenous shrinkage
 - Drying shrinkage

- ii) The total creep strain of concrete is defined as the sum of:
- a) Drying creep strain and basic creep strain
 - b) Drying creep strain, basic creep strain and shrinkage strain
 - c) Drying creep strain, basic creep strain, shrinkage strain and initial elastic strain
- iii) The phenolphthalein indicator test was used to determine the depth of carbonation present in concrete. At 5 mm depth, the test returned a purple colour. At 10 mm depth, the same test also returned a purple colour. These observations indicate:
- a) High pH at 5 mm depth and high pH at 10 mm depth
 - b) High pH at 5 mm depth and low pH at 10 mm depth
 - c) Low pH at 5 mm depth and low pH at 10 mm depth
- iv) What set of cementitious material mix design measures may be used to reduce the extent of delayed ettringite formation resulting in concrete?
- a) Increase type HE Portland cement use and increase fly ash use
 - b) Increase type SR Portland cement use and increase silica fume use
 - c) Increase type GP Portland cement use and increase fly ash use
- v) The properties of an over-reinforced concrete beam will change in what ways:
- a) Loading capacity will increase and cracking intensity will increase
 - b) Loading capacity will increase and cracking intensity will decrease
 - c) Loading capacity will decrease and cracking intensity will increase

Part 4B: List and Describe Short Answer Questions (10 marks)

Provide short answers for the following questions in your answer booklet.

- i) The initiation period of corrosion of steel reinforcement in a reinforced concrete structure is critical in design of service life. List and briefly describe three factors of concrete controlling the time taken for depassivation of the steel reinforcement.
- ii) List and briefly describe two main mix design features required to produce high strength concrete.

Part 4C: Graphical Relationship Questions (10 marks)

Provide the answers for the following question in your answer booklet.

- i) Draw the development of deformation (i. e., axial longitudinal strain) in a concrete member versus elapsed time for the following water and air storage conditions:
- a) Continuous storage in water for 6 months
 - b) Continuous storage in air for 6 months
 - c) Storage in water for 3 months and then storage in air for 3 months

***** END OF PAPER *****